



EVALUATION OF MOBILE PAYMENTS PENETRATION IN BALTIC COUNTRIES AND POLAND BY APPLYING MCDM METHODS

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Abstract. The purpose of this research is to analyse penetration and use of mobile payments in Baltic countries and Poland in point of sale (POS) segment. Mobile payment or m-payment (MP) is referred to the transfer of money (in digital form) from one party (e.g., consumer) to another party (e.g., seller or merchant) using a mobile device. Mobile payments allows to pay for goods or services with mobile devices instead of paying with cash or physical credit cards. The statistical data helps us to know information about mobile payments growth. The article concerns analysis of mobile payment use in POS systems. The penetration of mobile payments in countries is different. Lack of scientific information and novelty of this article provided by this research include methods for multi criteria decision support by applying SAW and TOPSIS methods. In this study case we demonstrate the evaluation of mobile payment use in Lithuania with comparison with other Baltic countries and Poland. The SAW and TOPSIS methods supply the structure of decision making which can help us to evaluate the penetration of mobile payments.

Keywords: mobile payments, penetration, point of sale, MCDM methods, mobile commerce, digitalization, simple additive weighting, technique for order of preference by similarity to ideal solution.

Introduction

The widespread penetration mobile payment (MP) systems could drastically change the methods in which consumers purchase goods and services. By 2017, the total transaction value worldwide through mobile wallet payments is over 350 billion of US dollars, and expects to grow at an annual rate of 39 percent and reach 1.6 trillion by 2022 (Agarwal et al., 2018). The high smart mobile phone penetration (e.g., 72% in the US) provides the infrastructure that allows consumers to make cashless payments almost anywhere (so long as they carry their mobile phones). The MP facilitates transactions, e.g., reduces the trouble of handling cash and the waiting time. This will move customer traffic more efficiently and raise customers' effective demand, mostly in shops involving small transactions.

Mobile payment services are interactive technologies, i.e. the value of using this technology will grow along with the number of new users. Therefore, some minimal number of users or "a critical mass" is necessary for their propagation (Song et al., 2009).

In addition, the mobile payment services market is a two-way market, i.e. it has two different types of users: consumers and enterprises of trade/services (or so-called distribution network companies). Consumers will want to use mobile payment service only if they allow for acceptance of payments by a sufficient number of distribution network companies; while distribution network companies will agree to connect to this service only on condition that they are used by a sufficient number of consumers. Consequently, the main task in the two-way market is to reach a critical mass of users on both sides, i.e. these services should be accepted by both sellers and consumers (Plouffe et al., 2000). Consequently, the acceptance of a payment service by sellers depends on the acceptance of the payment service by consumers and vice versa. Thus, if a critical mass of users is not reached on both sides of the market, the implementation of such a service will be unsuccessful, as there will be no incentives for them to be unilaterally accepted by one of the market participants (Mallat, 2007).

Aim of the research: to evaluate of mobile payments usage, that influence expandice of mobile commerce in Lithuania with comparison of other countries. *Research tasks:* 1) to analyse the chances of application of multicriteria decision making methods for evaluation of mobile payments usage in POS terminals; 2) to exhibit the assessment of mobile payments use in Lithuania with comparison of different countries; 3) to make observational research going to demonstrate to potential outcomes generally accepted methods to assess countries by mobile payments use in POS terminals.

Research methodology: methods of comparison and summarization, statistical data processing and a multicriteria analysis used during conduction of the research.

1. Theoretical background

A mobile payment is any payment where a mobile device is used to initiate, authorize and confirm a transfer of value in return for goods and services (Pousttchi, 2003). Mobile payments emerged in the 2000's, with early successes in the sale of mobile content and services such as ring tones and logos. Later, mobile payments were suggested as an alternative for micro-payments at point-of-sales systems, where the use of cash had been declining for many years. Many mobile and electronic payment solutions have been introduced ever since, but most of them have failed or have had a low penetration rate (Dahlberg et al., 2008). The "chicken and egg" situation for emerging payment models means that enough merchants need to be on-board with any new solution for it to catch on with consumers, but in order to be appealing to merchants there must be a critical mass of consumers interested. Lee et al. (2004) refer to mobile payment liquidity as the extent to which it is accepted by sellers and therefore adopted by customers. Au and Kauffman (2008) refer to the theory of network externalities to explain value creation in the networked economy, suggesting that the value of such services to banks and their customers will increase as the network grows. Standardisation and technology maturity have equally been highlighted as key requirements for expansion of mobile payments (Mallat et al., 2004; Lee et al., 2004).

So, while the most popular payment instruments are still cash, debit and credit cards (Dahlberg et al., 2008) with smart cards being the most serious challenger to traditional cash (Dahlberg & Mallat, 2002), the ways to make contactless payments and especially mobile payments are increasing. When looking into the future, companies and experts agree that the mobile phone is the technical device that they will try to turn into the new wallet, mainly because of the diffusion of mobile phones, which no other technical device can match, but also due to the fact that most of us carry our mobile phones with us most of the time (Olsen et al., 2011). Nowadays the mobile phone as e-wallet succeeds it will very likely be at the expense of traditional payment instruments. It is a possibility that the mobile payments will simply become a new way of entering the current card and account-based payment services (Dahlberg et al., 2008).

There is lack of research in analysing penetration of mobile payments from current technological, business and consumer perspective and such investigations could have a positive influence on mobile payment adoption. This provides the key motivation for the future research.

2. Evaluation of mobile payments usage in Lithuania with comparison of other countries

For evaluation of mobile payments usage was used multiple-criteria decision-making and multiple-criteria decision analysis. MCDM is well-known acronym for multiple-criteria decision-making. MCDM is concerned with structuring and solving decision and planning problems involving multiple criteria. The purpose is to support decision makers facing such problems unique optimal solution for such problems and it is necessary to use decision maker's preferences to differentiate between solutions. For this research we used The Technique for Order of Preference by Similarity to Ideal Solution TOPSIS method and the SAW (Simple Additive Weighting) method. For the evaluation of mobile payments usage in Lithuania with the examination of alternate countries, the beneath statistics are utilized.

Table 1. Mobile payment users in POS segment in millions (Statista, 2020) (designed by authors)

Country/ Year	2017	2018	2019	2020 (Forecast)
Estonia	0,04	0,05	0,06	0,07
Latvia	0,06	0,08	0,09	0,1
Lithuania	0,1	0,11	0,13	0,15
Poland	1,26	1,5	1,74	1,95

The numbers in the Table 1 demonstrates mobile payments users of a country for that specific year. In the all analysed countries usage constantly grows.

2.1. Evaluation using TOPSIS method

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multicriteria decision-making approach created by Hwang and Yoon (1981). It is a compensatory aggregation method based on the concept that the best alternative should have the shortest geometric distance to a positive ideal solution (PIS) and the geometric farthest distance from a negative ideal solution (NIS) (Krohling & Pacheco, 2015).

The TOPSIS process is carried out as follow:

STEP 1: Construct the decision matrix and determine the weight of criteria. (The sum of all the weights should be equal to 1).

STEP 2: Calculate the normalized decision matrix.

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}, \quad (1)$$

where n_{ij} = normalized decision matrix.

STEP 3: Calculate the weighted normalized decision matrix.

$$v_{ij} = w_j n_{ij} \text{ for } i = 1, \dots, m; j = 1, \dots, n. \quad (2)$$

where v_{ij} = weighted normalized decision matrix; w_j – the weight of the j-th criterion.

STEP 4: Determine the positive ideal and negative ideal solutions.

$$V^+ = (v_1^+, v_2^+, \dots, v_n^+) = \left(\left(\max_i v_{ij} \mid j \in I \right), \left(\min_i v_{ij} \mid j \in J \right) \right); \quad (3)$$

$$V^- = (v_1^-, v_2^-, \dots, v_n^-) = \left(\left(\min_i v_{ij} \mid j \in I \right), \left(\max_i v_{ij} \mid j \in J \right) \right), \quad (4)$$

where I is associated with benefit criteria and J with the cost criteria, $i = 1, \dots, m; j = 1, \dots, n$ and V^+ = positive ideal solution; V^- = negative ideal solution.

STEP 5: Calculate the separation measures from the positive ideal solution and the negative ideal solution.

$$S_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_i^+)^2}, \quad i = 1, 2, \dots, m; \quad (5)$$

$$S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_i^-)^2}, \quad i = 1, 2, \dots, m, \quad (6)$$

where S_i^+ = separation measure from positive ideal solution and S_i^- = separation measure from negative ideal solution.

STEP 6: Calculate the relative closeness to the positive ideal solution.

$$P_i = \frac{S_i^-}{S_i^- + S_i^+}, \quad (7)$$

where P_i = positive ideal solution.

STEP 7: Rank the preference order.

In the Step 1 constructed the decision matrix and determined the weight of criteria, results presented in Table 2.

Table 2. Results after applying the step1 of TOPSIS method (designed by authors)

Weight	0,25	0,25	0,25	0,25
Country/ Year	2017	2018	2019	2020 (Forecast)
Estonia	0,04	0,05	0,06	0,07
Latvia	0,06	0,08	0,09	0,1
Lithuania	0,1	0,11	0,13	0,15
Poland	1,26	1,5	1,74	1,95
Sum	1,46	1,74	2,02	2,27

In Table 2 it was given an equal weightage to every country as the total weight should be 1. So here weight for every country is 0,25.

Step 2, calculated the normalized decision matrix and results presented in Table 3.

Table 3. Results after applying the step 2 of TOPSIS method (designed by authors)

Weight	0,25	0,25	0,25	0,25
Country/ Year	2017	2018	2019	2020 (Forecast)
Estonia	0,033104236	0,0379049	0,04221585	0,046460632
Latvia	0,049656353	0,06064784	0,06332378	0,066372331
Lithuania	0,082760589	0,08339078	0,09146768	0,099558497
Poland	1,04278342	1,13714707	1,22425973	1,294260458

In Table 3 was calculated normalized decision matrix, and presented results of each country from year 2017 to 2020 (forecast).

Step 3, calculated the weighted normalized decision matrix, results presented in Table 4.

Table 4. Results after applying the step3 of TOPSIS method (designed by authors)

Country/ Year	2017	2018	2019	2020 (Forecast)
Estonia	0,00827606	0,00947623	0,01055396	0,011615158
Latvia	0,01241409	0,01516196	0,01583094	0,016593083
Lithuania	0,02069015	0,0208477	0,02286692	0,024889624
Poland	0,26069585	0,28428677	0,30606493	0,323565114

In Table 4 presented numbers after calculating the weighted normalized decision matrix. Multiply the columns of normalized decision matrix by the associated weights from entropy method. The weighted and normalized decision matrix is obtained.

Step 4, determined the positive ideal and negative ideal solutions, results presented in Table 5.

Table 5. Results after applying the step4 of TOPSIS method (designed by authors)

V+	0,26069585	0,28428677	0,30606493	0,323565114
V-	0,00827606	0,00947623	0,01055396	0,011615158

In Table 5 presented positive and negative ideal solutions for the statistics. These results obtained after comparing all countries data.

Step 5, calculated the separation measures from the positive ideal solution and the negative ideal solution, results presented in Table 6.

Table 6. Results after applying the step 5 of TOPSIS method (designed by authors)

Si+	Si-
0,569101129	0
0,559052405	0,01010332
0,544436448	0,02472327
0	0,56910113

In Table 6 was calculated separation measures from positive ideal solutions and negative ideal solutions the content of ideal and nadir ideal, distances of each alternative from the ideal and nadir for our problem, and the relative closeness to the ideal solution.

Step 6 results presented in Table 7.

Table 7. Results after applying the step6 of TOPSIS method (designed by authors)

Pi
0
0,017751422
0,043438201
1

In Table 7, after calculations established relative closeness to the positive ideal solution.

Step 7, calculated the rank of the preference order results presented in Table 8.

Table 8. Results after applying the step7 of TOPSIS method (designed by authors)

	2017	2018	2019	2020	Si+	Si-	Pi	Rank
Estonia	0,00827606	0,00947623	0,01055396	0,011615158	0,56910113	0	0	4
Latvia	0,01241409	0,01516196	0,01583094	0,016593083	0,55905241	0,01010332	0,017751422	3
Lithuania	0,02069015	0,0208477	0,02286692	0,024889624	0,54443645	0,02472327	0,043438201	2
Poland	0,26069585	0,28428677	0,30606493	0,323565114	0	0,56910113	1	1

In Table 8 presented rank of each country according to mobile payments usage. Lithuanian rank is 2 among 4 analysed countries. Better position has Poland, Latvia and Estonia following Lithuania.

2.2. Evaluation using SAW method

Simple Additive Weighting method is often also known as weighted summing method. The basic concept of SAW method is to find the weighted sum of performance ratings on each alternative on all attributes (Deni et al., 2013). The SAW method requires the process of normalizing the decision matrix to a scale comparable to all existing alternative ratings.

The SAW method is carried out as follow:

STEP 1: Construct the decision matrix and determine the weight of criteria. (The sum of all the weights should be equal to 1).

STEP 2: Calculate the normalized decision matrix.

$$\text{For minimum criteria } r_{ij} = \frac{\min_j r_{ij}}{r_{ij}}, \quad (8)$$

r_{ij} – i-th criterion’s value for j-th alternative; $\min_j r_{ij}$ – the smallest i-th criterion’s value for all the alternatives

compared; r_{ij} – denotes the converted values.

$$\text{For maximum criteria } r_{ij} = \frac{r_{ij}}{\max_j r_{ij}} \quad (9)$$

$\max_j r_{ij}$ – the largest i-th criterion’s value of all alternatives.

STEP 3: Calculate the weighted normalized decision matrix.

$$w_i^* \bar{r}_{ij}, \quad (10)$$

w_i – weight of the i-th criterion; \bar{r}_{ij} – normalized i-th criterion’s value for j-th object; $i = 1, \dots, m; j = 1, \dots, n$; m – the number of the criteria used; n – is the number of the objects (alternatives) compared.

STEP 4: Calculate the sum.

$$S_j = \sum_{i=1}^m w_i \bar{r}_{ij}. \quad (11)$$

STEP 5: Rank the preference order.

The one of the limitations of the SAW method is all the criteria must be positive so if we have the negative values they should be transferred to the positive values. The transformation can be done as follow:

$$\bar{r}_{ij} = r_{ij} + \left| \min_j r_{ij} \right| + 1. \quad (12)$$

Step 1 results presented in Table 9.

Table 9. Results after applying the step1 of SAW method (designed by authors)

	MAX	MAX	MAX	MAX
Weight	0,25	0,25	0,25	0,25
Country/ Year	2017	2018	2019	2020 (Forecast)
Estonia	0,04	0,05	0,06	0,07
Latvia	0,06	0,08	0,09	0,1
Lithuania	0,1	0,11	0,13	0,15
Poland	1,26	1,5	1,74	1,95

The comparison matrix is shown in Table 9, indicating the relative importance of the criterion in the compared to the criterion in the rows. Here were taken maximum criteria.

Step 2, calculated the normalized decision matrix and results presented in Table 10.

Table 10. Results after applying the step2 of SAW method (designed by authors)

	MAX	MAX	MAX	MAX
Weight	0,25	0,25	0,25	0,25
Country/ Year	2017	2018	2019	2020 (Forecast)
Estonia	0,03174603	0,03333333	0,03448276	0,035897436
Latvia	0,04761905	0,05333333	0,05172414	0,051282051
Lithuania	0,07936508	0,07333333	0,07471264	0,076923077
Poland	1	1	1	1

In Table 10 presented results after calculating the normalized decision matrix.

Step 3, calculated the weighted normalized decision matrix, results presented in Table 11.

Table 11. Results after applying the step 3 of SAW method (designed by authors)

	MAX	MAX	MAX	MAX
Weight	0,25	0,25	0,25	0,25
Country/ Year	2017	2018	2019	2020 (Forecast)
Estonia	0,00793651	0,00833333	0,00862069	0,008974359
Latvia	0,01190476	0,01333333	0,01293103	0,012820513
Lithuania	0,01984127	0,01833333	0,01867816	0,019230769
Poland	0,25	0,25	0,25	0,25

In Table 11 presented result after calculating the weighted normalized decision matrix. This table illustrates the effect of weights on the normalized matrix by multiplying the acquired weight vector from BWM on the decision making matrix.

Step 4, calculated the sum, result presented in Table 12.

Table 12. Results after applying the step4 of SAW method (designed by authors)

	MAX	MAX	MAX	MAX	SUM
Weight	0,25	0,25	0,25	0,25	
Country/ Year	2017	2018	2019	2020 (Forecast)	
Estonia	0,00793651	0,00833333	0,00862069	0,008974359	0,03386489
Latvia	0,01190476	0,01333333	0,01293103	0,012820513	0,05098964
Lithuania	0,01984127	0,01833333	0,01867816	0,019230769	0,07608353
Poland	0,25	0,25	0,25	0,25	1

The Table 12 represents the outcomes subsequent to computing the sum of each country for every year.

Step 5, ranked the preference order, results presented in Table 13.

Table 13. Results after applying the step 5 of SAW method (designed by authors)

	MAX	MAX	MAX	MAX	SUM	RANK
Weight	0,25	0,25	0,25	0,25		
Country/Year	2017	2018	2019	2020 (Forecast)		
Estonia	0,00793651	0,00833333	0,00862069	0,008974359	0,03386489	4
Latvia	0,01190476	0,01333333	0,01293103	0,012820513	0,05098964	3
Lithuania	0,01984127	0,01833333	0,01867816	0,019230769	0,07608353	2
Poland	0,25	0,25	0,25	0,25	1	1

The Table 13 demonstrates the position of every country as per the use of mobile payments in POS segment in Baltic countries and Poland from 2017 to 2020 (forecast). Lithuanian rank is 2 among 4 analysed countries. Poland leads in usage of mobile payments and the Latvia and Estonia are relatively close to each other.

From the results it is observed that Lithuania, Latvia, Poland and Estonia obtained the relative closeness to ideal solution and the ranks are 2, 3, 1, and 4 respectively. The Poland is identified as the best country for mobile payment providers \ among the considered ones which has the best relative closeness value. TOPSIS and SAW is applied to achieve final ranking preferences in descending order, thus allowing relative performances to be compared.

Conclusions

Mobile payments (MP) directly responsible for grow of mobile commerce. Subsequent to investigating the insights and utilizing the two strategies (TOPSIS and SAW), we can see which country has the highest MP use and access in Baltic countries and Poland for as far back as 3 years and we can likewise observe which country positions first in MP use. From the practical result of the two analysis we can see that Poland stands first, Lithuania stands second, Latvia stands third and Estonia stands fourth as per the MP usage in point of sale segment. By the assessment of MP use in Lithuania in correlation with alternate countries, we can know how Lithuania has a feasible advancement in all analysed organizations. The exact research demonstrates that we can assess countries by mobile payment use in POS segment by applying the multicriteria basic leadership strategies. The constraint of this exploration is, that were examined just 4 countries since we couldn't locate the entire insights and we utilized just two multicriteria basic leadership strategies (TOPSIS and SAW) in light of the fact that there are no master assessments for these measurements. This exploration could help to form strategies of increasing mobile commerce in Lithuania and encourage the grow of mobile payments users. The results equally can be used as recommendations for MP start up or worldwide companies looking for business establishment or expansion possibilities in eastern Europe region.

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